

## LUCY

Lucy, the 10th typhoon, was in most respects a typical winter season storm. Development was difficult and near the equator while recurvature occurred at a low latitude. An unusual event happened during the development stage when the system divided into two disturbances and then recombined 2 days later.

As with the previous typhoon (Kim), Lucy's birth was a "double vortice" development pattern discussed by many authors. The earliest accounts of tropical storms occurring simultaneously on both sides of the equator are described in a book "The Law of Storms" by Reid (1849). In this particular case the tropical cyclone in the Southern Hemisphere near equatorial trough (NET) developed first and was well on its way to maturity before Lucy formed in the Northern Hemisphere NET. The expanding circulation about the Southern Hemisphere TC 24-77 (Steve) strengthened the westerly flow along the equator increasing the horizontal shear along the Northern Hemisphere NET aiding the development of Lucy (Fig. 4-30). On the 26th, 33 kt (17 m/sec) gradient level winds were observed at Tarawa (WMO 91610), an island about 75 nm (139 km) north of the equator. Westerlies extended above 500 mb and created an extensive horizontal wind shear trough north of the equator. Enough cyclonic spin was imparted over the Marshall Island area that the nearby preexisting disturbance began to develop. All factors for further development were present therefore, at 270600Z a Tropical Cyclone Formation Alert was issued.

A large mid-tropospheric anticyclone dominated the subtropical western Pacific and concentrated strong trade winds north of the depression. The system soon began accelerating westward as it neared the anticyclone's southern domain. Synoptic data indicated an increase in circulation size and satellite imagery showed better organization. Weather

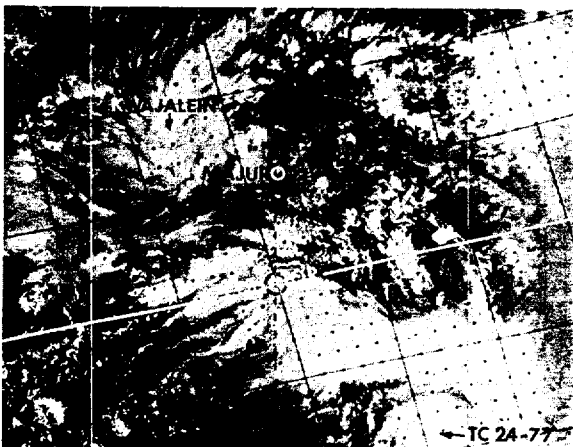


FIGURE 4-30. "Double Vortices". Lucy is seen in her formative stage in the Northern Hemisphere NET between Kwajalein and Majuro while TC 24-77 (Steve) is near maturity in the Southern Hemisphere NET, 25 November 1977, 2118Z. (NOAA-5 imagery)

reconnaissance aircraft were sent in to investigate further. Early on the 28th aircraft found a 997 mb surface pressure center with 30 kt (15 m/sec) surface winds and 45 kt (23 m/sec) flight level winds at 1500 ft (457 m). JTWC thus issued their first warning on TD 20 at 280600Z. Six hours later the depression crossed the southern coast of Ponape (WMO 91348) with only 10 kt (5 m/sec) sustained and 25 kt (13 m/sec) gusts reported. These unexpectedly weak surface winds supported prior aircraft reports which observed maximum winds at flight level, not surface.

On the 29th TD 20 split into two disturbances. One went northwestward and the other west-southwest around the Truk Islands (Fig. 4-31). This split occurred when increasing amplitudes in the mid-latitude long wave patterns strengthened the subtropical, mid-tropospheric anticyclone which was positioned north of TD 20. The pressure gradient between TD 20 and the high pressure cell generated 45 kt (23 m/sec) easterly flow at 500 mb. The resulting intense, horizontal shear produced enough vorticity to induce a secondary circulation system just north of TD 20. As they separated, both systems weakened as their energy sources also became divided.

Because the northern system was generated in the mid-troposphere, it was reflected on the surface only as a weak depression. Infrared satellite imagery identified the northern split as having more activity at higher levels. Aircraft and synoptic data indicated better organization in the southern split. The northern system reached a maximum forward speed of 20 kt (37 km/hr) as the pressure gradient peaked. This rapid movement

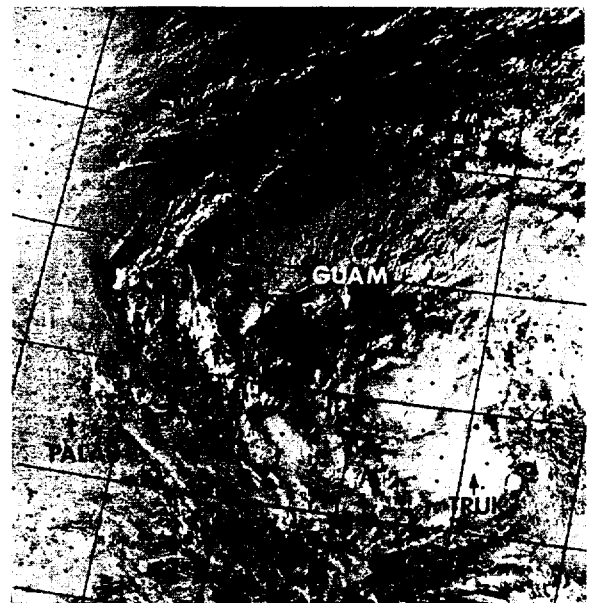


FIGURE 4-31. Lucy during an unusual split configuration while over the Caroline Islands, 29 November 1977, 2125Z. (DMSP imagery)

placed the secondary disturbance well ahead of TD 20's primary circulation. As the dual system moved westward away from the dominating influence of the subtropical high, horizontal shear and induced vorticity diminished. This resulted in the northern system's deceleration and dissipation. The southern, primary, system soon caught up to and absorbed the remnants of the northern system 100 nm (185 km) northwest of Woleai Atoll. By 0000Z on the 1st of December, TD 20 was again a single system with the same intensity as it was before the split.

TD 20 now began heading northwestward around the southwestern periphery of the steering anticyclone toward a break in the subtropical ridge. Deceleration and intensification progressed for the next 2 days. TD 20 became Tropical Storm Lucy at 010600Z. Aircraft data, however, still indicated that the storm was best developed in the middle layers. This was again evidenced when Lucy passed 25 nm (46 km) northwest of Yap (WMO 91413) which only experienced 15 kt (8 m/sec) sustained surface winds and a sea-level pressure minimum of 1001 mb.

Continuing northwestward, Lucy appeared to be heading for a recurvature path. An intense, short-wave trough was passing north of Lucy, with an apparent weakening in the subtropical ridge. But the trough quickly passed, trailing a migratory anticyclone behind and Lucy again took a more westward track. Now headed for the Republic of the Philippines, Lucy attained typhoon intensity at 020600Z and continued to deepen. Synoptic and satellite data showed excellent upper

level divergence in all quadrants. Aircraft reconnaissance began reporting maximum winds nearer the surface, indicating better vertical development. By this time Lucy attained a maximum intensification rate of 20 kt (10 m/sec) per 6 hours and satellite data revealed a large, well defined eye (Fig. 4-32).

By the 3rd of December, Lucy was again heading northwestward as a strong westerly trough began creating another weakness in the subtropical ridge. In 24 hours the ridge west of Lucy had completely dissipated. Lucy's easterly steering currents rapidly weakened under increasing pressure from the advancing trough. At 1800Z on the 3rd, a 115 kt (59 m/sec) maximum intensity was reached with a minimum forward speed of 8 kt (15 km/hr). Within the next 12 hours, Lucy recurved ahead of the approaching trough.

The storm soon became completely embedded in mid-latitude westerly flow and accelerated northeastward. Lucy was downgraded to tropical storm stage 48 hours after recurvature. Upper level vertical shear and low level cool, dry entrainment became the significant factors for weakening. Lucy was eventually steered into a frontal zone and became an extratropical wave within the boundary.

The last warning was issued at 071800Z. Lucy's extratropical transformation extended over several days since both polar and tropical air flows converged into the system. Lucy traveled eastward as a weak cyclone along the front and was eventually absorbed into a large, winter storm system over the central Pacific.

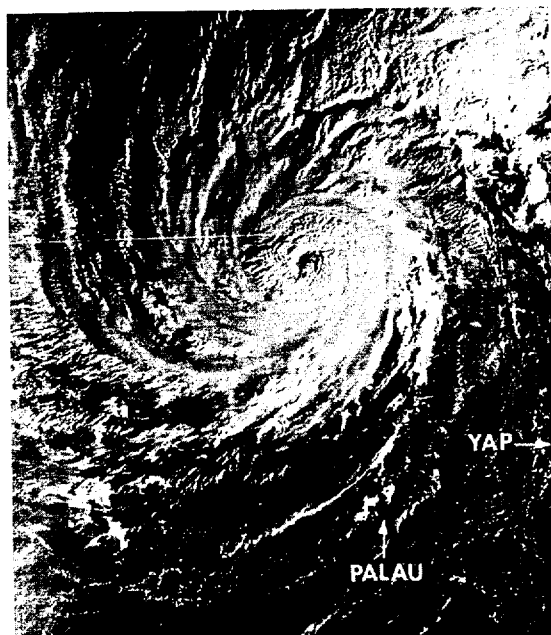


FIGURE 4-32. Typhoon Lucy with 85 kt (44 m/sec) winds and undergoing rapid deepening, 2 December 1977, 2215Z. (DMSP imagery)